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Article

The Electromagnetic Induction of Mystical and Altered States within the Laboratory

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ABSTRACT

The human brain is the locus of all human experiences. The substantial microstructural and neuroelectrical differences between the two cerebral hemispheres predicts two major classes of mystical experiences which involve the sensed presence and the out-of-body experience. Their occurrence and their attributions to cosmic origins have been reported for centuries and have been the bases for social belief systems. Direct cerebral electrical stimulation during the 20th century evoked these experiences. In the 21st century the non-invasive, external transcerebral application of complex, physiologically-patterned weak magnetic fields has been shown to produce similar experiences that can be correlatively mapped by quantitative electroencephalographic inferences of interhemispheric coherence. The experimental production and control of these powerful experiences by more sophisticated technologies might be employed to understand the intricate nature and function of mystical/altered states within large populations of human beings.

Key Words: mystical states, out-of-body-experiences, sensed presence, biofrequency electromagnetic fields, consciousness.

1. Introduction

The history of science has been the gradual reinterpretation of the primary passive perceptions of human experience through quantification and experimental verification. The apparent centrality of earth for solar movement, special creation of human beings, and rationality of human behaviour have been refuted as either illusionary or artifacts of perception. With each successive shift in the interpretation, the unique significance of human experience has been replaced with more general descriptions that reflect the basic principles of the natural world.

The sense of the human self, associated with phenomenology such as consciousness, self-awareness, moral decision-making, and the capacity to conceptualize its own dissolution ("death"), have been shown to be correlated with specific patterns of brain activity. Mystical experiences, associated with altered states of consciousness, are characterized by an expansiveness of space or time with a concomitant enhanced meaningfulness of the experience with respect to the boundaries of the self. In general these experiences are affectively positive and operate functionally to reduce the anxiety associated with the apprehension of self dissolution. The positive reinforcement of the state within which the experiences

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occur enhances their meaningfulness as well as the validity of the sense of locality and unique importance of the self.

Mystical states are represented fundamentally in two forms. One involves the experience of another Sentient Being proximal to the experient while the other involves the perceived localization of the self within another frame of reference at times and distances significantly different from the experient's location. During these periods the person experiences information that is considered unattainable through the normal state and has been a major source of creativity and insight. They often transcend the formal education of the person or the contemporary sophistication of the culture.

The experimental duplication and neuroscientific understanding of these phenomena can be considered important for three reasons. First, they may reveal the mechanisms by which creativity and novel problem solving emerge within neuronal processing. Second, experiences and information attributed to Sentient Beings are sometimes employed as proofs of cosmic consent to validate the experient's beliefs and as rationalizations to subjugate or exterminate those who report different beliefs. Third, if all experiences are generated by or correlated with cerebral activity, then contemporary or future technologies that can influence mystical processes within large populations could be employed without the people's awareness. Here we discuss the development, rationale, and results of our experimental productions of mystical experiences.

2. Human Brain Structure and Mystical Experiences

If structure dictates function and microstructure dictates microfunction, then the most conspicuous prediction is that the human cerebrum with its two hemispheres should exhibit two major configurations. Despite the apparent similarity of the topographical organization of the gyri and sulci over the left and right hemispheres, only four sulci of the approximately 200 discernable sulci and gyri over both hemispheres share geometric characteristics. All of the others reveal a marked cerebral asymmetry.

The differences and similarities are reflected in the two fundamental states of cerebral functions: wakefulness and dreaming. The phenomenology of wakefulness is dominated by the left hemispheric sequential processing of images associated with verbal symbols and their categorical organization. Ideas are integrated primarily as a function of perceptual and denotative similarity. The phenomenology of dreams is more dominated by right hemispheric spatial imagery organized by similarities of emotional meaning and connotation.

There are transient intercalations between the two processes. If the left hemispheric processes are activated during dreaming and one awakens the subsequent representation into verbal images facilitates not only awareness but memory of the dreams. Temporal delays of about 300 s result in awareness of only fragmented dream images while delays of 1 ksec typically are associated with no recollection at all. This occurs despite the learning, although state dependent and not easily accessible during waking, that has been demonstrated during the dreaming.

Yet the two states show marked electroencephalographic (EEG) similarities. During both waking and dreaming EEG patterns are dominated by complex fast activity suggesting information processing. Llinas and Ribary (1993) found that the phase-shifting continuous waves of integrated electromagnetic fields that move in rostral to caudal direction over the cerebral hemispheres are almost identical during the waking and dream state. Both are quite different from what is observed during slow wave sleep.

2.1 Hemispheric Functions and Two Primary Mystical States

More than a hundred years of neuropsychological data and approximately 20 years of functional measurements through fMRI (functional Magnetic Resonance Imaging), PET (Positron Emission Tomography), SPECT (Single Photon Emission Computerized Tomography) and QEEG (Quantitative Electroencephalography) have quantified the differences in left and right hemispheric functions. The left hemisphere is more involved than the right hemisphere with sequential linguistic processes while the right hemisphere is more involved than the left with spatial, affective, and vigilance-related functions. These differences are also generally reflected in two types of associative learning: 1) sequential or serial, optimally associated with hearing, and, 2) simultaneous or parallel, optimally associated with the visual modality.

These functions are not exclusive to a specific hemisphere. The right hemisphere displays some linguistic capacity. Experiments have indicated that the right hemisphere on average displays the syntactic level of a six year old and the semantic limits of a pre-adolescent. Similarly the left hemisphere displays some visual spatial processing ability. For many functions the amount of explained variance for quantitative measures associated with lesions or injuries within the left or right hemisphere is in the order of about 20% to 30%. This means there is substantial variance associated with individual differences in brain organization.

That the sense of self is strongly correlated with linguistic processes classically associated with left hemispheric function has been considered by many authors. This assumption is embedded within many Eastern philosophies and states that the “self” is a social fiction and does not exist. From this perspective, the propensity for cultures, that can be defined as groups of people with shared language and expectancies, to be willing to fight or to die to maintain their language is predictable. Without one’s culture there would be no “self” as usually experienced. The anticipated dissolution of the self may be the basis of the most incapacitating anxiety that is paired with a person’s death.

That anxiety about death is a semantic paradigm that can be appreciated with the operational analysis of the simple sentence “I will die”. The semantic equivalent of anticipation “will”, between the locus of reinforcement (“I” or the self) and the presentation of an aversive stimulus (“die”) induces predictable behaviour consequences that have been described as the conditioned emotional response, conditioned suppression, or simply anxiety. Any counter-neurocognitive process that reduces the consequences of this operation (anxiety) will be reinforced with sufficient intensity that it affects the manner in which the person perceives, organizes, and predicts the world. The latter behaviours define the essential components of what constitutes human belief.

The coupling between human experience and belief occur phenomenologically and are consistent with the likely neuroanatomical substrates (Wallis et al, 2001). Experiences are involved with more caudal regions of the cerebral hemispheres while the organization of these experiences with respect to what is expected, socially acceptable, or ethically and morally compatible, involve the prefrontal regions. When beliefs and their more secular variant, attitudes, become connected to overt responding either singly or in a group then the destructive or constructive potential becomes a physical probability. As aptly stated by Buckman (2004), as long as the behavioural actions (upon others) potentially generated from beliefs remain disconnected, beliefs and experiences should have the entire range of expression. When they are acted upon, their damaging consequences to the individual’s potential become apparent.

Almost 30 years ago Kate Makarec and I hypothesized that if traditional left hemispheric processes are associated with the sense of self, than there must be a right hemispheric equivalent of the “sense of self”. However its characteristics would be influenced by the functions of the right hemisphere. It would be

more dominated by affect or profound personal emotion, spatial references, and minimal verbal imagery. This "self" would be familiar yet sufficiently diverse to be differentiated from the self.

When we first applied physiologically-patterned weak magnetic fields over the right hemisphere more than the left, the majority of normal volunteers reported a "sensed presence". This presence was described by many as a "Sentient Being" that was beyond the experient but associated with such personal significance and relevance that emotional responses were common. On the basis of these early experimental results we suggested that the "sensed presence" was the left hemispheric awareness of the right hemispheric equivalent of the sense of self.

The "intrusive", "ego-alien" nature of the experience and the propensity for experients to attribute the source of the phenomena not to themselves or to the applied magnetic fields but to "another" entity was revealing. We realized that the sensed presence, if it were due to the awareness of the right hemispheric equivalent of the left hemispheric sense of self or due to the transient intercalation of some process between the left and right hemispheres, might be the basis for the trans-cultural reports that have ranged from the Muses of the Ancient Greeks to various forms of gods, deities and "other dimensional" beings to contemporary societies.

Because the first major source of aggregate or group differences within human beings is gender, a consequence of the differences between XX and XY chromosomes and reflected in the dozens of sexually dimorphic structures coupled to these genetic rather than environmental determinants, there are marked sexual differences in the frequency and details of the sensed presence. In a series of double-blind studies Persinger (2003) and his colleagues applied weak (1 μT or about 10 mG), specifically and physiologically-patterned transcerebral magnetic fields across the temporal lobes of 100 male and female volunteers.

A significantly greater proportion of women reported experiences of sensed presences than did the men. This was commensurate with the well known greater electroencephalographic coherence (or intercorrelation) between the two temporoparietal regions observed for the average woman. For men the sensed presence was attributed to ego-alien intrusions while for women the sensed presence was *also* associated with vestibular sensations, out-of-body experiences, fear, and the feeling of being "in another place".

2.3. Vectorial Hemisphericity

If one assumes left hemispheric processes are associated with the sense of self and right hemispheric processes are associated with the sensed presence, then there should be two classes of phenomena. The first, as indicated, involving the intrusion of right hemispheric processes into left hemispheric awareness would be experienced as a sensed presence. The second would maintain the integrity of the sense of self as it intrudes into right hemispheric processes. We hypothesized these experiences would be associated with reports of out-of-body experiences that have been described also as "astral" projections.

The vectorial hemisphericity hypothesis (Persinger,1993) was based upon the concept of molecular and cellular anisotropy whereby at some critical spatial asymmetry of charge or energy, the vector of the current flow or energy moves to the lower potential difference or energy level. Consequently for an intrusion of right hemispheric processes into the left hemisphere, either the right hemisphere must be activated above normal or the left hemispheric must decrease to below normal levels. Similarly for intrusion of left hemispheric processes into the right hemisphere, the left hemisphere has to be activated to above normal levels or the right hemisphere must decrease to below normal levels.

The first quantitative question that required answering was why are the frequencies or incidence of sensed presences and out-of-body experiences so low? One possible candidate involves the normal physical restraints or impedances for interhemispheric interactions. The numbers of neurons each with an axon (but potentially more than one collateral branch) and multiple dendritic displays are about 40 billion per hemisphere. For simplicity, this would be about 100 billion neurons per cerebral cortices.

The two major tract systems that interconnect the two hemispheres are the Anterior Commissure and the Corpus Callosum. The latter contains on average about 200 million axons. This means that only about .1% to 1%, depending upon assumptions, of neurons from one hemisphere is directly connected to the other. Effectively the human cerebrum is two distinct loci of intrinsic information processing. Even when one includes the contributions from the Anterior Commissure, which interconnects the ventral temporal cortices and anterior subcortical limbic regions, the proportion of direct neuronal cross-over would be in the order of 1%.

For either a sensed presence or an out-of-body experience to occur we have assumed a critical value, analogous to a critical mass, whereby the pattern of neuronal activity in one hemisphere is represented somewhere in the other. Even with interhemispheric propagation durations in the order of a few msec, there is still the requirement of bulk velocity to maintain the pattern of activity associated with the gestalt or whole experience.

2.4 Populations More Likely to Experience the Sensed Presence

According to the vectorial hemisphericity hypothesis certain forms of psychological depression would be associated with sufficient diminished left temporal lobe activity to allow the intrusion of the right hemispheric equivalent. Clinically, the numbers of patients who experience these presences and undergo a transformation in personality or "conversion" to the belief to which the experiences were attributed, are very frequent. With the reactivation of left hemispheric functions the person often displays the profile of the temporal lobe personality described by Fedio and Bear (1977).

In addition to the feeling that the person "is a recreated self" or some variant description, there are concomitant beliefs that the person has been selected by some external source. The viscosity of thought produces a reiterative focus on the experience and its implications that are often so subjectively profound there is a compulsion to maintain detailed written records, often to the point of hypergraphia. As expected by activation with the subcortical temporal structures, particularly the amygdala, unusual or expected events are perfused with emotional and usually personal significance juxtaposed upon cosmic implications.

Invariably, the social components of such conversions are reflected in a range of proselytizing activities to convince others of the cosmic or personal significance of information that was obtained during the experience or the philosophy attributed to post-experiential associated "Sentient Being". The impacts of these behaviours depend upon context. Creative individuals such as writers, artists, or musicians, can positively influence the potential of multitudes of others. Still other individuals who focus upon "the word" as a requirement to which all that hear must follow, can, within shared social consensus, reduce the culture and the cultures with whom they interact to stereotyped patterns of subjugation.

Other physiological conditions that can promote the intercalation between left and right hemispheric processes include sudden and life-threatening distress. Out of body experiences would be associated with the enhanced left hemispheric activity relative to the right and hence intrusion into these processes. Differential blood flow between branches of the Posterior Cerebral Artery and the Middle Cerebral Artery, both of which innervate the regions of the occipital cortices coupled to the peripheral and central (foveal)

visual fields respectively, quickly induce a tunnel-like visual experience. The subsequent feelings of movement, meaningfulness, visualization of the personal past, darkness and white light also reflect the vascular changes within cerebral structures associated with these experiences.

The creative writer often displays these experiences during the early morning hours when the normal right hemispheric enhancement inhibited by the maintained left hemispheric awareness of waking intrudes into awareness. Hypomanic periods facilitate this condition because of the globally elevated cerebral activity that increases the probability of more frequent optimal conditions for the intercalation as the baseline tone of interhemispheric reciprocal inhibition intermittently disinhibit. Because of the relatively greater activation of the left hemisphere the experiences are linguistically dominant and in some instances may be experienced as "an inner voice", including the "calling" of the experient's name.

The population of human beings that experience the most versatile and subjectively rich mystical states are those who exhibit electrical foci within the temporal lobe. The functional organization of complex partial epileptic or temporal lobe epileptic patients encourage the experiences of sensed presences and detachments from the body into "other dimensions" as the repeated overt and covert paroxysmal discharges diffuse through their cerebral space. In status-like conditions these states may be prolonged and associated with maximally enhanced emotions that can range from rapture to terror. During these states they may experience information, attributed to a distant land or Sentient Being, that can exceed the apparent limits of their personal and cultural learning.

Another population that experiences the sensed presence is those who have sustained "minor" closed head injuries from the impact of mechanical energy, with or without the loss of consciousness (Persinger, 1994). Sandra Tiller and I noted that during our clinical neuropsychological assessments that the majority of these patients experienced a sensed presence. More than 95% of the patients who reported the sensed presence felt as if they were no longer the same people as they were before the injury. Their subjective profiles are very similar to those of patients diagnosed with partial complex electrical seizures.

If the sensed presence is experienced as occurring along the left side, the sensation is primarily associated with unpleasant emotions. If the sensed presence is experienced as occurring along the right side the emotion is more positive and the person may actually "hear" his or her name called or a "message". For the vast majority of these experients the perceived genders of the presences are opposite to their own. Although the duration of an experience is in the order of about 10^1 s, routine EEG measurements during neuropsychological assessments for hundreds of patients ultimately captures a few occurrences.

In one case (Persinger and Tiller, 2008) the subjective experiences of an "electric shock", icy coldness, vibrations through the whole body and the sensed presence were associated with 4-5 Hz paroxysmal activity over the temporal lobes. The pattern was similar (although less organized) to the 3 to 4 Hz spike and slow-wave train of paroxysmal activity that occurred for about 10 sec over the right temporal lobe following a routine 15 min meditation session for an experienced female teacher of transcendental meditation. She reported during this period a feeling that an Infinite Presence identified as God had been with her in the laboratory.

During the late 19^{th} century Hughlings Jackson had astutely attributed the "parasitic" or second "consciousness" that was frequently reported by temporal lobe epileptics to electrical anomalies within the right temporal lobe. The many correlative and historical examples of likely endogenous electrical stimulation within the temporoparietal regions and the repeated display of the two classes of mystical experiences as well as religious conversions were reviewed by Dewhurst and Beard (1970). Bear (1979) delineated clusters of behaviours that increase in frequency during years of intrinsic neuroelectrical

stimulation in epileptic with temporal lobe foci. He suggested that sensory limbic hyperconnectionism resulted in a progressive investment of perception and thought with affective significance. This singular process contributed to the marked range and qualitative differences in the interictal behaviours that evolve within these individuals.

These (inferred) hemispherically anisotropic changes can result in significant impact upon culture and society. There is now evidence that Socrates' capacities may have been correlated with altered states during which he engaged in conversations with "nonvisible" entities. Many religious conversions over the centuries, involving known to less known personages (Bradford, 1999) whose cosmically "acquired" information formed the bases for beliefs of millions to billions of people, can be considered predictable examples of the consequences of the vectorial hemispheric processes.

3.0 Experimental Production of Mystical Experiences

3.1 Invasive Electrical Stimulation

Since the experiments during the late 19th century by Fritz and Hitzig who electrically stimulated fresh human brain and recorded movement from the body, researchers have realized that the neuroelectrically active brain can be affected by exogenous stimuli. The formal development of neurosurgery during the middle of the 20th century demonstrated that all of the components of mystical states, from the feeling of a presence nearby to "being" somewhere else, could be produced by appropriate electrical stimulation of primarily the temporal lobes, especially within the right hemisphere. The mesiobasal regions, defined as the hippocampal-amygdaloid region, were particularly important.

The classic clinical experiments by Vernon H. Mark and his colleagues (Stevens, et al, 1969) are illustrative of these experiments. They stimulated the electrodes placed within the amygdala-hippocampal regions of patients with 0.1 to 3 mA, 100 Hz, 1 ms rectified square waves. Stimulation of the amygdala produce the most elaborate and confused mental states that included feeling far away, "Nirvana-like" pleasantness, mental diplopia (the self looking onto the scene), déjà vu, and fear. The cerebral (surface) electroencephalographic activity during these periods was dominated primarily by theta (4 Hz to 7 Hz) activity. It became evident during these types of experiences that the patient's mental content at the time of the stimulation was a determinant of the content of the resulting hallucinatory experiences (Mahl, et al, 1964).

Bancaud et al (1994) extended Penfield's observations that dreamy states occurred sometimes in epileptic patients (about 10% of the cases) during electrical stimulation of the lateral temporal neocortices, particularly the superior temporal gyrus. Pierre Gloor's important contribution was that these experiences were strongly influenced by hippocampal-amygdaloid stimulation. Bancaud et al (1994) stimulated cortical and mesiobasal temporal lobe structures for about 5 s with trains of rectangular, unidirectional pulses (50 pulses/s) whose durations were 1 ms with potential differences between 2 and 12 V. Again, in addition to the expected visceral sensations, déjà vu and the incorporation of memories into current contexts, the primary themes were out-of body-like experiences and sensed presences. The paroxysmal feeling that somebody was nearby was evoked by electrical stimulation of the right amygdala (Ardila and Gomez, 1988).

The major neurophysiological correlate of the propensity to experience these types of altered states for these patients may be the epileptic foci. Anninos and Tsagas (1989) measured these areas with

magnetoencephalography and found dense concentrations of isocontour lines within the 2 Hz to 7 Hz range. They occurred frequently in the cerebral tissue beneath the presumed electric focus on the scalp. Normal people did not display such dense isocontours. Stimulation of the "electrical foci" by a myriad of subtle physiological conditions (such as subtle alterations in extracellular potassium levels), unusual environments (Suedfeld and Mocelllin, 1987) and exogenous synchronizations, (such as geomagnetic activity or patterned-matched experimentally produced applied magnetic fields) could initiate activation.

The recent work of Olaf Blanke and his colleagues have demonstrated the cerebral-connection to both classes of mystical experiences. Electrical stimulation of the temporparietal junction through implanted electrodes into epileptic patients resulted in out of body experiences and sensed presences (Blanke et al, 2004). The type of experience was in large part determined by the hemisphere in which the stimulation occurred. In general, stimulation of the right hemisphere produced detachment while stimulation of the left hemisphere was associated with sensed presence-like reports.

Other researchers (Desmurget et al, 2009; Kiani and Shalden, 2009) have shown the electrical stimulation of the right inferior parietal region triggered strong intention and desire to move the homunculus-related portion of the other side of the body. With increased stimulation patients believed they had actually performed the movements even though no electromyographic activity was recorded. What they experienced as occurring had not occurred. Stimulation of these regions was associated with the certainty of a choice while stimulation of premotor areas actually produced overt mouth and contralateral movements of the limbs that the patients firmly denied had occurred.

There has been a long history in clinical neurology and neuropsychology that patients who sustain injury to the right (inferior) parietal regions display neglect of the contralateral side. More exotic experiences such as experiencing a "second self" or "other identical person" with such conviction that the person attempts to find that person has been reported occasionally. In apparent contrast, spontaneous visual experiences of "small humanoid" or "ethereal human forms" have been associated with electrical foci in the right temporal region.

This apparent contraction could be accommodated by recent measurements that show that patients with identified lesions within the (right) parietal lobe display anomalous metabolic and electrical activity within the adjacent temporal lobe. Karnath et al (2001) showed that the loss of the strongly spatial-awareness based functions associated with right parietal lesions effectively interfered with the right superior temporal cortices. Such interconnections reiterate the importance of realizing that focal lesions result in disinhibition of connected areas. The corollary to that statement is that interpretations of the increased metabolic activity within an area should include an appreciation for the inhibitory or excitatory functions and connections of the area.

3.2 Whole Brain Correlates of Mystical States

Although direct stimulation by implanted electrodes allows the systematic presentation and removal of input to selected areas, the procedure is invasive. In addition the subjects are usually epileptic patients who have failed to respond to pharmacological treatments. The electrical currents induced to evoke the experiences are within the mA range and must be of sufficient intensity to produce relatively immediate effects. The duration and propagation of the afterdischarges, whose intensities may attenuate to within the range sufficient to intercalate with normal neuroelectrical activity, may be equally important. The quantitative duration of the afterdischarge is associated with either an increase or decrease in ACTH (adrenocorticotrophic hormone) levels, factors that can contribute to immunosuppression or immunofacilitation.

The recent development of non-invasive measurements such as fMRI (functional Magnetic Resonance Imaging), PET (positron emission tomography), quantitative EEG (QEEG) and SPECT (Single photon emission computerized tomography) have been particularly revealing. In clinical cases the sensed presence during an epileptic aura with religious overtones was shown to be associated with bilateral hypoperfusion within the temporal lobes (Lantdbloom, 2006). The seminal work by Newberg and his colleagues (2001, 2010) has shown that sensed presences occurring during periods of prayer, thought, or meditation were more associated with increased metabolic activity within the right parietal regions.

The importance of the task or subjective experience requested by the experimenter is critical to the area of the brain that is activated. For example, Beauregard and Paquette (2006) who asked individuals with a life-long history of religious belief to remember their experiences with a god, showed more activation in the cerebrum associated with the reconstruction of experiences or memory. They included the right prefrontal regions. Similarly Azari et al (2001) showed that subjects engaged in religious recitation showed more activation of the frontal-parietal pathways composed of the dorsolateral prefrontal, dorsomedial frontal, and medial parietal cortices.

This is an important distinction in light of Devinksy and Lai's (2008) report that the temporal lobe is involved with religious experiences while alterations in frontal functions may contribute to increased religious interests as a personality trait. That in turn may affect the person's predilection for choosing specific religious-related vocations. Wiech et al (2008), employing fMRI found that experience of analgesia during episodes of pain was enhanced by religion as a belief system and involved the right ventrolateral prefrontal cortices.

These prefrontal regions are also associated with moral judgements and treatment of other human beings (Moli et al, 2003). That these areas can be indirectly and experimentally modified as well as the moral adjustments associated with them was reported by Young et al (2010). By disrupting neuronal activity within the right temporoparietal junction through transcranial magnetic stimulation (TMS), the role of beliefs in moral judgements was reduced. Given the rich interconnection between this region and the prefrontal regions associated with beliefs, such powerful effects are not surprising.

The effect also strongly suggests that compensatory increases in activity within this region would *increase* the role of beliefs whose validity has been inferred by specific experiences to moral judgements. The strong congruence between these neural networks and the display of behaviours classified as schizophrenia (Taber and Hurley, 2007) when these networks operate differently could accommodate the frequent concurrence between this condition and mystical or religious states within pathological rather than normal contexts (Buckley, 1981).

3.3 Non-Invasive Experimental Production of Mystical Experiences in Normal People

We have been applying transcerebral magnetic fields with complex temporal patterns in order to affect the neural substrates of the processes associated with consciousness and mystical states. The average increased field intensity associated with the physiologically-patterned magnetic field near the scalp on each side of the skull at the level of the temporal lobes is about 5 uT (50 mG). The energy storage from an applied field of 5 uT within the cerebral cortices would be the cerebral volume of 1.1×10^{-3} m^3 multiplied by $[(5 \times 10^{-6} T)^2]/[2*12.56*10^{-7} N/A^2]$. When multiplied by .44 (the ratio of the volume that is cortices), the energy "storage" is about 6×10^{-9} J. With continuous presentation the value would be J/s or 6 nanoWatts.

This is a billion times less than the energy within the brain associated with glucose metabolism. However,

here the critical feature is the electromagnetic field. Each action potential with a net change of about 120 mV or 1.2 x 10^{-1} V exerts on a unit charge of 1.6 x 10^{-19} As an energy of about 2 x 10^{-20} J (Persinger, 2010). Assuming there are between 10^{10} and 10^{11} neurons in the cerebral cortices with an average firing rate of about 10 (10^{1}) Hz, the total energy associated with the primary correlate of experience, the action potential, would be between 10^{-9} and 10^{-8} J. In other words, the experimentally applied magnetic fields that produce the very significant changes in specific experiences associated with changes in cognitive states and correlative quantitative EEG profiles, generate bulk energies that are equivalent to those associated with the electromagnetic energies of cortical neuronal function.

The amount of energy required to produce the sensed presence is less intense than intuitively expected. Booth et al (2005) found that consistently increasing intensity of about 1 pT/s (10^{-12} T/s) within the east-west component of the geomagnetic field for about 10 min with a cumulative change of between 15 to 20 nT was sufficient to be associated with the report of sensed presences by normal volunteers seated within an acoustic chamber while they were being stimulated with transcerebral magnetic fields. Quantitative EEG measurements indicated that during the experimental induction of a sensed presence by circumcerebrally rotated 1 uT magnetic fields, there was increased power within the theta band over the right parietal and frontal lobes within very focused peaks. They were 4 Hz to 5 Hz and 7 Hz to 8 Hz, respectively (Booth and Persinger, 2009) with a beat range between 3 Hz and 4 Hz (delta power).

4. Externally Applied, Weak, Physiologically-patterned Magnetic Fields

4.1 The Field-Field Interaction

The metaphor we have employed is that the interaction between these weak magnetic fields and the electromagnetic substrates that mediate consciousness and mystical states, particularly the sensed presence and the out-of-body-experiences, are less related to direct current induction and more related to field-to-field interactions. The process would be more similar to the interaction between the interplanetary magnetic field within the solar wind associated with the expanding solar corona and the earth's magnetic dipole. The typical field strength of the solar wind is about 7 x 10^{-9} T while the static dipole of the earth's magnetic field is 5 x 10^{-5} T, a difference of almost 10,000. Yet the interface within the outer magnetosphere where the intensities converge mediates powerful effects throughout the four-dimensional space occupied by the geomagnetic field and is reflected within powerful changes deep within the volume, which in this instance is the earth's surface.

The quantitative convergence between the energy contained within our applied magnetic fields and those generated by the EM component of neuronal activity indicates that a quantitative threshold is present to allow direct intercalation in a manner similar to the interaction between the solar wind and the outer components of the magnetosphere of the earth. Quantitative EEG data indicate that a sequence of stimulation by between 1 and 5 uT fields at the scalp's surface with as little as 10% greater intensity over the right hemisphere compared to the left is associated with greater convergence of theta activity between the left temporal and right prefrontal region. Subsequent bilateral stimulation is associated with greater right-to-left temporal coherence. These two experimental conditions and quantitative EEG patterns are associated with reports of out-of-body experiences and the sensed presence, respectively.

4.2 Connection to Consciousness and EM fields

Our primary assumption is that consciousness and its variants of mystical states can be expressed as

quantum phenomena, as predicted by Niehls Bohr and others. If consciousness and thought are coupled to electron movements, then a macroscopic manifestation should be congruent with the magnetic field strengths associated with neurocognitive activities. Access to the information within the movements of an electron, its fundamental charge, and the photon emissions associated with changes in electron movements, would allow mystical states and the information with which they are associated to have alternative interpretations that recruit the fundamental properties of space-time and matter.

The operating intensity of the cerebrum has been measured and calculated to be in the 1 to 100 pT range with a wide band of coefficients. From this context it is interesting that kg/As * 1/s or the mass of an electron divided by a unit charge multiplied by 7 Hz is 9.1×10^{-31} kg/1.6×10^{-19} As * 7 Hz (1/s) or 40×10^{-12} T. This relationship is closely coupled to the Zeeman effect whereby the application of a magnetic field produces an additional or a third spectral line in an absorption spectrum by inducing different quantum levels. The change in angular frequency with an applied field of 40×10^{-12} T would be, according to classic Zeeman formula solutions, the product of 4×10^{-11} T * 1.6×10^{-19} As divided by 12.56 * 9.1×10^{-31} kg or about 0.6 Hz. However in non-angular systems it would be 7 Hz.

The spatial gradient of the fields could contribute to their effectiveness for facilitating mystical experiences. The 10% increased intensity over the right side compared to the left side of the cerebrum to produce the sensed presence is equivalent to about 1 pT per 10 um, the width of a cell. The amount of energy from this change in magnetic field intensity within a neuronal soma would be $[(10^{-12})^2/2.5 \times 10^{-6}$ N/A^2] * 5×10^{-16} m^3 or in the order of 10^{-34} J. If this value is divided by Planck' constant, 6.6241×10^{-34} J s, the frequency is within the 1 to 10 Hz range. This indicates that within a narrow range of pT gradients and widths of neuronal soma, the net frequency equivalence would be within the 10 Hz range.

The congruence in quantification is apparent when the magnetic moment of the electron and its spin, which is 10^{-24} J/T is multiplied by this intensity. The base 10 level of the energy is within the order of 10^{-34} J. Again the frequency equivalence of this value when divided by the fundamental modulator of quantum phenomena, Planck's constant, is within the range of brain activity. At the minimum level of 10^{-35} J the mass equivalent approaches 10^{-52} kg which is a value found by a variety of measurements and inferences to be the likely rest mass of the photon.

4.3 We May Be Influencing the Secondarily-Induced Magnetic Field

Our data and approach support the concept of the double induction concept for influencing the magnetic field fields associated with consciousness. This would be analogous to influencing the change of a change or a derivative. According to the equation $(\delta B/\delta t)$ m^2 the voltage from an applied field of 30 mG (3×10^{-6} T) over 1 cm (10^{-4} m^2) with a frequency equivalence of 333 Hz (3 msec point durations for the serially changing values that create the patterns) would be 10^{-7} V within a cm area. Assuming 300 ohm cm for resistance of interstitial fluid, then the current would be 10^{-9} A.

Application of the Biot-Savart law would indicate a magnetic field perpendicular to the current direction according to $u\ I/4\pi\ r^2$. With a distance of 1 mm the magnetic field strength would be $10^{-16}/10^{-6}$ or 10^{-10} T. This is within the operating intensity of the cerebral magnetic field. If some process could maintain the equivalence to the level of the cell membrane, 10 nm, the functional equivalent of the induced magnetic field would be in the order of the earth's static magnetic field of 1 G (10^{-4} T). This coupling would potentially allow a direct connection between the flux line density of the static earth magnetic field and the intensity of change that typifies the range of the dynamic vector of the time-varying magnetic component of the cerebrum.

The Biot-Savart effect predicts that any effect that involves the steady-state component would be directional. Booth et al (2005) found that 1 pT/s sustained increases for about 10 to 15 min within the east-west component of the earth's magnetic field was associated with the report of sensed presences. Interestingly the latency for the onset of dream sleep is shortened when volunteers sleep in an east-west compared to north-south position (Ruhenstroth-Bauer, et al, 1993). Even visual sensitivity can be influenced differentially by inverting periodically for about 30 min the vertical component of the earth's magnetic field (Thoss, et al, 1999). Superimposed with this simple directionality is the observation that the application of complex, physiologically-patterned weak magnetic fields (200 to 500 nT) can enable the organism to detect and respond to localized static anomalies (185 uT) almost a 1000 times more intense (McKay and Persinger, 2005).

4.4 Method of Application

Although the basic principles operative within the physical world can be expressed often as simple and elegant conceptual expressions, such as the force between units is a product of their magnitudes divided by their distance-squared, the application geometry often determines the expression of these effects. The classic example is the geometry-dependent positive or negative pressures of Casimir forces. These "expressions" are usually the phenomena that we measure and in which science constructs the technology employed to interact with other physical systems. Structure dictates function, or, stated alternatively, the application geometry of fundamental processes actually defines the degrees of freedom and the information within the phenomena that emerge from very fundamental processes.

Thirty years of our research, involving cell cultures, rats, mice and human beings, have clearly demonstrated that the application of spatially homogeneous symmetrical time-varying magnetic fields are one of the *least* useful means of affecting complex biological processes in general and the correlates of human consciousness in particular. This empirical observation reiterates that convenience of modelling by simplistic mathematical geometries for verification of theory may be not be equally valid when applied to the complexity of biological systems.

The biological effectiveness of applied magnetic fields is related to their spatial and temporal heterogeneity. Criterion efficacy involving weaker intensity magnetic fields is almost completely opposite to the conditions that produce the enhanced acuity associated with MRI (Magnetic Resonance Imaging). To discern the intricate details of a complex space application of a maximum homogeneous field intensity enhances the interference patterns that allow the computerized reconstruction of that space. To *interact* with that space the temporal and spatial structure of the applied field must approach the characteristics of that space.

There are two metaphors that might illustrate the concept. First, a complex temporal sequence like a sentence can be screamed or whispered. The amount of energy between the two modes could differ by a factor of a million (e.g., 30 db vs 90 db). However the information within the syntax of the sentence does not change. Second, for a simple molecular structure, like NaCl, to be anomalously effective the concentration might exceed the molar range. For a more complex structure, such as LSD (lysergic acid diethylamide) to be effective, the concentrations would be millions of times less. Even the mirror image with the "same" structure (the stereoisomer) is less effective. In both examples the diminutive magnitudes required to exact the physiological-chemical changes are functionally related to their congruence within the intrinsic microstructure of the brain within which they are interacting.

If we assume that consciousness is a field then it would be composed of quantized units at some level of spatial and temporal organization. The specific pattern of interaction between subsets of these units

would mediate and contain the information within that field. Application of a homogeneous field would not necessarily change the relative relationships between these ratios of interaction. In an analogous manner the fundamental microstructure of neurons A, B, and C is organized such that axons and axonal collaterals form A→C and A→B→C allows for a consistent ratio converging on C regardless of the absolute intensity presented at A.

However application of a heterogeneous magnetic field through brain (or organismic) space with a Δs of spatial heterogeneity that approaches the → Δs of the structural unit of the field that creates or is correlated with consciousness should produce the maximum effect. This comment is contingent upon the assumption that the timing or point duration Δt of the applied field that interacts with quantized unit is resonant with its Δt. As predicted we have found that 64 solenoids distributed evenly over the head produces more intense alterations in consciousness and mystical states than 8 solenoids, even when controlling for differential in applied summed magnitudes of the fields.

Over the last 30 years we have found that for rat and human studies the greater the heterogeneity of the spatial gradients of the intensity of the applied magnetic field within the three dimensional space occupied by the organism or the brain of the experient, the greater the resulting effects with less and less intensity. Obviously there is a minimum threshold defined by the sensitivity of the system, which is a function of its spatial and temporal resolution, to which the field is applied. In fact, much like the phenomena of receptor agonism and effective current density for cell repair, the relationship between magnitude of the applied field and the effect is non-linear where intensities (like concentrations of ligand) below or *above* a particular magnitude are less effective.

4.5 Contemporary Application Geometries

Stanley Koren and I initially developed the four-pair solenoid system for transcerebral stimulation of the temporal lobes based upon the concept of spatial-temporal heterogeneity. The four solenoids (reed switch relay coils) embedded permanently in each side of a helmet are connected in pairs such that at any given time one pair is activated. A commutator changes which pair is activated at any given time. Within either 2 or 20 sec, depending upon the study, one complete cycle has been completed (each pair has been activated in a serial sequence). An alternative design has been two containers each embedded with the four solenoids that are placed on each side of the head. The latter design allows more flexibility for the application of the fields over specific regions of the brain. By either a switch or orientation the intensity of the applied field to the right or left side of the head the strength can be modified within a range of about 10% to 50%.

Professor Todd Murphy generalized the system by employing the magnetic solenoids employed as sensors for recording telephone conversations. When a small current is generated through them they generate magnetic fields that can be focused over specific regions of the cerebrum. He further simplified the process by driving the pairs of solenoids with input from wave-files generated by computers. As a result very complex applied electromagnetic patterns, which might ultimately be considered the language of the brain, became available to anyone who had a computer and access to commercially purchasable solenoids.

4.6 The Importance of the Point Duration

Unlike traditional function generators, our fields are generated by computer files. Each file contains a column of numbers between 0 and 255 that are translated into increments of voltages between -5 and +5 V by custom-constructed digital-to-analogue converters. The current then activates the solenoids in the helmet or solenoid containers. The duration of each number (and hence each voltage) is activated, called

the point or "pixel" duration, is programmable. The numbers of lines in a file range from about 200 to 10,000, although millions could be employed for durations approaching a day. When graphed such that the horizontal axis is the sequence and the vertical axis is the voltage (-5 to +5) or numerical range (0 to 255, with 127 as 0 polarity), reveals the shape of the pattern. This flexibility allows the creation of an unlimited number of potential patterns.

After experimentation with different point durations, the 3 ms duration has been found effective for inducing mystical states in humans and analgesia in rats (Martin et al, 2004). Durations less or more than this value, at least between 1 and 10 ms, are less effective and may produce no changes at all. To insure the voltage associated with each number between 0 and 255 is precisely 3 ms, software programs must be added to most computers after the IBM 286 models to maintain the duration. The failure to monitor the real time of point durations, particularly with computers that employ WINDOWS, may result in no significant effects. For example the report by Swedish researchers (Granqvist et al, 2005) who did not control the point durations indicated no differences in mystical experiences between exposed and sham groups. The actual scores for both of their groups were almost identical to our sham field exposed groups (Persinger and Koren, 2005), suggesting that the optimal field parameters were not applied.

The 3 ms point duration has been found to be essential even for stimulating molecular pathways and calcium influx into the cells. Robert Lafrenie and Carly Buckner have shown that diminished cell growth in different lines of cancer cells but not normal cells occurs primarily with point durations of 3 msec for their applied fields from the same computer-generated patterns that produced the mystical states. The fields had to be applied for at least 30 min before a significant influence was discerned although marginal changes began after about 15 minutes. Point durations of either 2 ms or 4 ms are less effective and 1 ms or 5 ms are not different from sham field treatments. The effect is visually obvious when observing calcium transport into cells.

The 3 ms duration was predicted by Persinger and Koren (2007). Their calculations indicated that the resonant point duration for the expansion of a proton (or electron) width to increase one Planck's length as inferred by Hubble's constant, was between 1 and 3 ms. The congruence with this value and the range for durations in action potentials for neurons suggests that such precision in numerical values must be achieved to allow resonance that integrates large areas of cerebral space with fundamental physical processes.

The duration of continuous exposure to the appropriate pattern is usually in the order of at least 30 minutes with the first changes occurring after 1 ksec. As shown in Figure 1 a measure of global entropy from the quantitative EEG measurements of a normal subject does not begin to change until after about 15 min of exposure to the helmet-generated magnetic fields. The field was activated after a baseline period of no field without the subject's awareness. When the field was terminated after 30 min of exposure, note that the return to baseline measures required about 5 min.

This latency of responding indicates that the effects of the applied fields upon the measures of brain states were not artifacts of current induction. If they had been the onset would have been immediate and the decline would have been immediate. The approximately 15 min maintained stimulation before the global state shifted is commensurate with the responses following whole body exposures in rats and pervasive applications to cell cultures. The discrepancy by a factor of about 3 between the time required to produce a change in global state and its attenuation to baseline suggests that the field produces a condition that produces a state during which the sensed presence or out-of-body experience occurs.

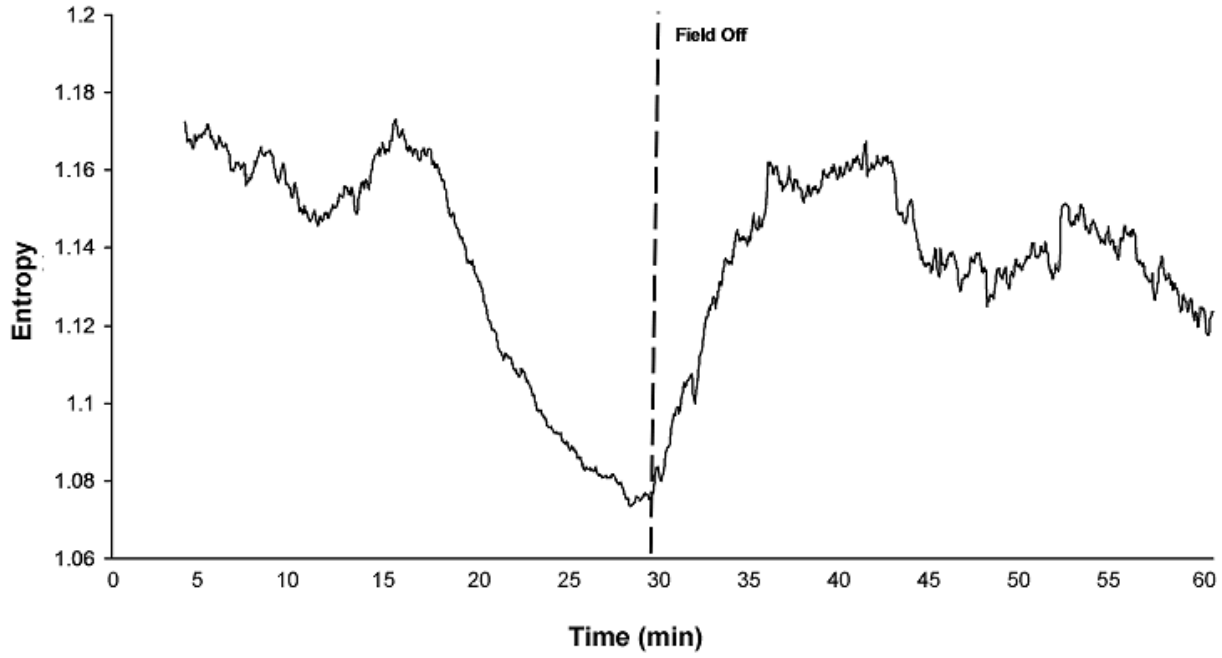

Figure 1. Information entropy indices for global brain activity as a function of time after the onset and offset of the 1 μT transcerebral, physiologically-patterned magnetic field. Note about 15 min of continuous exposure is required before the changes begin. They begin to asymptote to baseline five minutes after the field was stopped.

4.7 The Pattern of the Fields

Sine-wave, symmetrical-shaped magnetic fields, unless there is an intrinsic changing phase-modulation, has been least effective for producing mystical states. Irregular shaped patterns with intrinsic burst-firing and frequency-modulated features have been most effective. The two major shapes we have pursued are the burst-firing and Thomas pattern (Figure 2). Both are irregular frequency-modulated shapes. The power spectra for the two at 3 msec point durations are also shown in Figure 2. As can be seen there is a distribution of energies with different amplitudes over a band of biofrequency ranges. We do not show the power spectra of, for example, a 60 Hz sine wave because it would be a straight vertical line at 60 Hz.

The temporal pattern of the applied field for its effect is as important as the spatial (molecular) shape of a molecule is to its influence. For producing mystical experiences, particularly the sensed presence, a simple reversal of the shape during the presentation produced no sensed presence. A similar effect was noted with cell responses in culture. Fragmentation of the pattern and the presentation of only parts of the pattern (analogous to injecting only a fragment of an effective molecule) also produced no effect upon diminishing proliferative activity of cells.

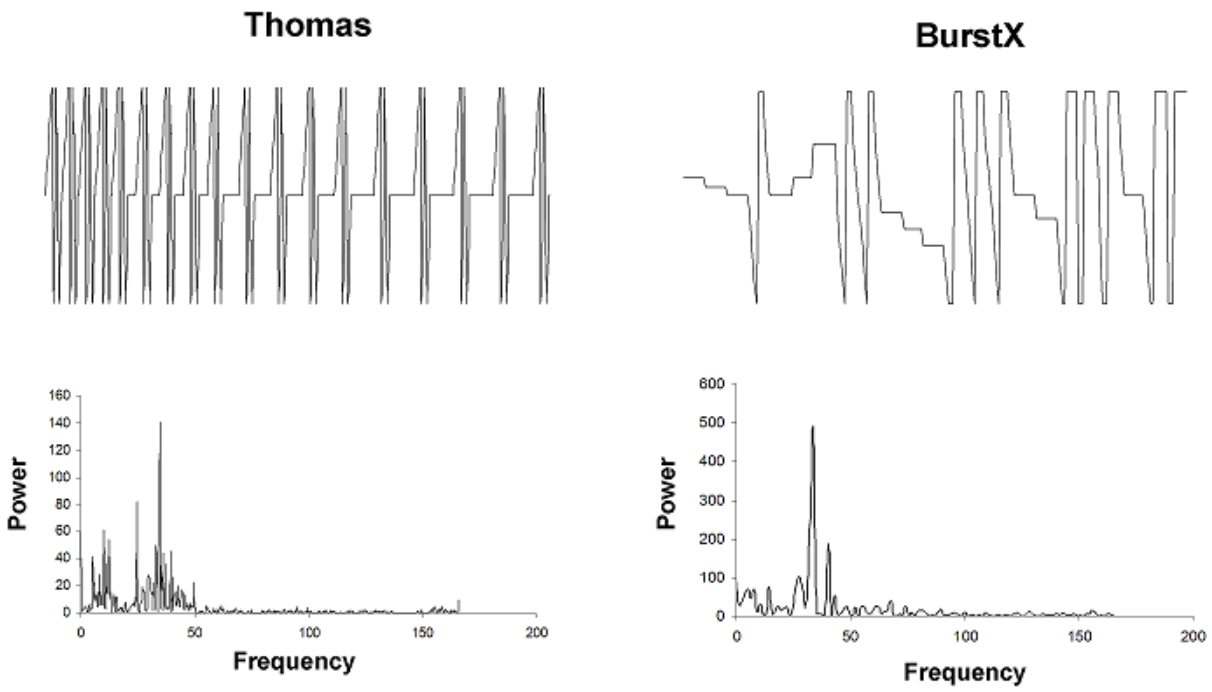

Figure 2. Spectral power (in relative units as a function of frequency) for two essential patterns that have been employed to induce the sensed presence and the out-of-body experiences. The "Thomas pulse" is a decelerating frequency-modulated pattern. The "burst-firing pulse" is an accelerating "burst-firing" frequency modulated pattern.

4.8 Why Frequency-Modulated vs Fixed Frequency Fields?

The presentation of symmetrical fixed frequencies, such as 60 Hz sine-waves within an envelope does not allow for frequency shifts. On the other hand irregular frequency modulation within a group velocity can create the condition for information to be received and transmitted. The frequency modulated patterns when presented as repeated envelopes from the computer sequences produce a superimposed band width that is more related to higher order derivatives or rates of change that might, under particular conditions, minimize the masking effects from thermal agitation at biological temperatures (37 deg C).

As articulated by W. Ross Adey, the potential difference (voltage) associated with the thermal level of a living system can be calculated by taking the square root of 4kTBR where k is the Boltzmann constant of 1.38×10^{-23} J/T, T=is the temperature, B is the band width in Hz and R=300 ohm cm, the typical resistance of interstitial fluid. For a 1 Hz band the threshold above which an applied field must induce a voltage to exceed thermal effect would be 2.3×10^{-9} V. The current (i) associated with this voltage within the resistance of 300 ohm would be in the order of 10^{-12} A, well within the pA range of the classic ion channel. This suggests that even a 1 Hz increment or band width could mediate effects that could affect one of the fundamental electrophysiological quantum of consciousness. The magnetic field associated with this current in a torus-like membrane would be $B=\mu i/2\pi r$, where r is the width of the membrane, or 12.56×10^{-7} N/A^2 * 7.5×10^{-12} $A/6.28 \times 10^{-8}$ m which is equal to 1.5×10^{-10} T. This too is well within the range of operating bulk intensity of the cerebral volume.

In addition to the greater temporal congruence between the patterns of the asymmetric applied fields and

intrinsic neuroelectromagnetic activity, there is another factor that may enhance the latter's impact: habituation. According to the general relationship $T_i=IRT^2/R_t$ where the numerator is inter-response time and the denominator is the duration of the response, the time required to approach the inflection where the strength of responding asymptotes is calculable. For a symmetrical 60 Hz field the time between each symmetrical wave is 16.6 ms and the duration is the same. Hence the habituation would occur within less than 20 ms. This is less than the threshold for the perception of "now " or the duration of a percept.

On the other hand the asymmetrically applied fields show variable IRTs and durations that when summated appropriately result in T_i values in the order of 1 ksec (about 15 min) particularly if the pattern is continuously being rotated to one of four pairs of solenoids. As a result during any given rotation there is a slightly different sequence of the shape of the field being presented at that pair of solenoids even though the pattern is continuously generating.

4.9 Comparison to TMS

The differences in magnitudes between the field strengths associated with Transcranial Magnetic Stimulation (TMS) developed by George et al (1995) and the Transcerebral Magnetic Stimulation (TCM) employed in our studies (Baker-Price and Persinger, 1996) is in the order of about one million. However in clinical settings both produce similar effect sizes for the treatment of clinical depression, particularly for patients who have sustained mild to moderate depression subsequent to closed head injury. How could treatments with such great discrepancies in field strength produce such similar effects?

One potential solution to this apparent contradiction involves the duality between the energy associated with cell metabolism vs the energy associated with the electromagnetic activity associated primarily with the cell membrane. The energy associated with the application of physiologically-patterned magnetic fields in the order of 1 uT (10 mg) is $J=[B^2)/(*4\pi\ \mu)]* m^3$. With an average cerebral volume of 10^{-3} m^3, this is equivalent to 10^{-9} J. Assuming 10^{-20} J of energy associated with each action potential (Persinger, 2010) and each neuron firing on average 10 times per second, there would be sufficient energy to interact with about 10 billion neurons. This value is within the same order of magnitude as the numbers of neurons within the human cerebral cortices.

On the other hand the application of a TMS field with a strength of 1 T would be associated with energy in the order of 10^3 J, and, concerning the greater focal nature of the application and the μs pulse durations, is more likely in the 10^1 to 10^2 J range. These values are within the 10 J/s to 20 J/s (10 to 20 W) output of the whole cerebrum associated with metabolic activity. This reflects the more general observation that glucose utilization per cell in the brain is about 1 to 10 picoJoule and with a total of about 1 trillion cells (considering the copious contribution from the cerebellum and glial cells) the integrated output would be in the order of 10 J.

4.10 Convergence With and Accommodation of the Blanke Results

The results and approaches of our research and those of Olaf Blanke both show that out-of-body-experiences and the sensed presence can be generated experimentally by stimulating either one or the other of the hemispheres within specific regions. The quality of the experiences, although direct comparisons have not been made, appears to be similar and the quantitative or meaningful intensity reveal similar values for individual salience.

The primary difference in general, in addition to the application of weak applied circumcerebral magnetic fields compared to direct surgical stimulation or its equivalent, is the apparent opposite hemispheric

sources. Whereas our research indicates that a slight right hemispheric stimulation encourages the sensed presence and elevated left hemispheric-right prefrontal activation is associated with the out-of-body-experience, Blanke's results show the opposite effect. The apparent contradiction can be accommodated by application of the vectorial hemisphericity principle.

The current intensities employed by direct current stimulation to evoke changes quickly rather than over a 30 min period as with our procedures evoke substantial reactive inhibition through spreading after-discharges. Considering the substantial reciprocal inhibition of neurons in one hemisphere of neurons in the opposite hemisphere through axon collaterals, one would predict that the hemisphere of subtle activation within the neuronal pT range associated with consciousness would bias towards the opposite hemisphere. On the other hand the application of weak magnetic fields over this area would induce pT range magnetic field within cerebral space directly.

This inference would indicate that both of our laboratories are investigating similar phenomena but they are being induced through different mechanisms because of the nature of the intercalation between the two hemispheres. Interestingly, if one employs dimensional analysis to obtain magnetic field strength from a different perspective, Blanke's 50 Hz, 2 s stimulations in the left temporoparietal area would have been sufficient to affect suppressor areas. If we assume he stimulated 1.5×10^{-9} kg of functional neuronal space, then the "associated" magnetic field strength would be [1.5×10^{-9} kg]/[(10×10^{-3} A(*(1/50 Hz)*2 s)] or about 4 μT, within the range of our effective field strengths. This alternative approach must still be tested empirically but may allow a quantitative convergence between the two approaches.

4.11 The Importance of the Context and Reduction of Sensory Input

During the pilot experiments performed by Pauline Richards and me during the 1980s it became evident that the report of the experience of a sensed presence or the out-of-body experience was dependent upon the sensory environment. Reflecting upon historical contexts in which powerful and sociologically significant sensed presences have been experienced, most of our experimental inductions have occurred within a partial sensory diminished setting that simulates a cave, dessert, or related isolated area. In most cultures, conditions that promote introspection also enhance the probability of sensed presences attributed to cosmic sources.

In our experiments, but not those employed for the routine procedures suggested by Professor Todd Murphy for his Shakti System which also generates significant sensed presences and "self-detachments", subjects sit within a quiet, completely darkened room (an acoustic chamber) and are blindfolded. From our perspective this allows the millions of neurons within the cerebrum that passively and actively responds to visual and auditory stimuli to be available to be recruited into the neuronal patterns induced by the applied fields. Consequently the applied energy of the field can be reduced because the background "noise" level is substantially lower.

We have also found that even though the person is blind folded the presence of a dim (about 1 to 10 lux) red light, particularly near the end of the spectrum (700 to 800 nm wavelengths that are employed for photographic development) increased the incidences of sensed presences if the appropriate magnetic field configuration is being presented. Initial experiments to facilitate temporal lobe stimulation by simultaneously playing low intensity exotic music during the application of the field actually suppressed the occurrences of sensed presences.

Expectancy in large part determines the verbal labels that the person places upon the experiences and these verbal labels, with their cognitive associations and images, are the experiences that are retrieved or

reconstructed as "memories" following the exposure. The experiences are quite ephemeral, as shown by specific button press studies where the instruction was given to press a button when a sensed presence occurred. Unless the person paired the experience with a label, that could range from "spirit" to his or her "own brain", recall of the experiences as measured by exit questionnaires was low.

Consequently great care has been taken to insure that expectancies of the context are neutral. Volunteers are recruited for "relaxation studies". The experimenters who conduct the experiments are not aware of the actual hypothesis associated with the experiment or the expected consequences of the various physiologically-patterned fields.

5. General Patterns of Subjective Experiences and Quantitative Electroencephalographic Correspondence

5.1 Subjective Profiles and General Statistical Correlates

St-Pierre and Persinger (2006) reviewed and re-analyzed the approximately 20 experiments involving 407 subjects that have demonstrated the experimental elicitation of either the sensed presence or out of body experience. Linda St-Pierre's re-analyses clearly showed the specific magnetic configurations and not the subjects' exotic beliefs or suggestibility was responsible for the increased incidence of sensed presences. The subjects' histories of spontaneous sensed presences before the experiment (and exposure to the magnetic fields) were moderately correlated with exotic beliefs and temporal lobe sensitivity. The side attributed to the presence at the time of the experience was affected by the parameters of the fields, the hemisphere to which they were maximized, and the person's *a priori* beliefs.

The richness of the experiences, which were similar to those from direct invasive electrical stimulation, is characterized by selected cases. For example one 21 year old female with a history of diabetes reported "I felt a presence behind me and then along the left side. When I tried to focus on the position, the presence moved. Every time I tried to sense where it was, it moved around. When it moved to the right side, I experienced a deep sense of security like I have not experienced before. I started to cry when I felt it slowly fade away (we had changed the field patterns).

A 25-year old man with a history of three "mild" head injuries, who had completed his four year university education, reported an out-of-body experience during the field exposure. In this instance the point duration for the values that composed the frequency modulated field was 1 ms, much like those of the direct electrical stimulation parameters employed by neurosurgeons. He reported "I feel as if there was a bright white light in front of me. I saw a black spot that became a funnel….no tunnel that I felt drawn into. I felt moving, like spinning forward through it. I began to feel the presence of people, but I could not see them. They were along my sides. They were colourless and grey looking. I know I was in the chamber but it was very real. I suddenly felt intense fear and felt ice cold."

5.2 QEEG and sLORETA Patterns

Within the last year, by employing the software associated with portable quantitative EEG technology and the algorithms associated with Low Resolution Electromagnetic Tomography (sLORETA), the convergence between the vectorial hemisphericity hypothesis, patterns of subjective descriptions of sensed presences and out-of-body experiences, and global brain activity has been possible. The major results are shown in Figure 3. For subjects who report an out of body experiences the beta coherence occurs between the left temporal lobe and right prefrontal region. Metaphorically the "self", a left hemispheric process, accesses

the spatial organizational properties of the right prefrontal region. On the other hand those who experience a sensed presence show delta coherence between the left and right temporal lobes.

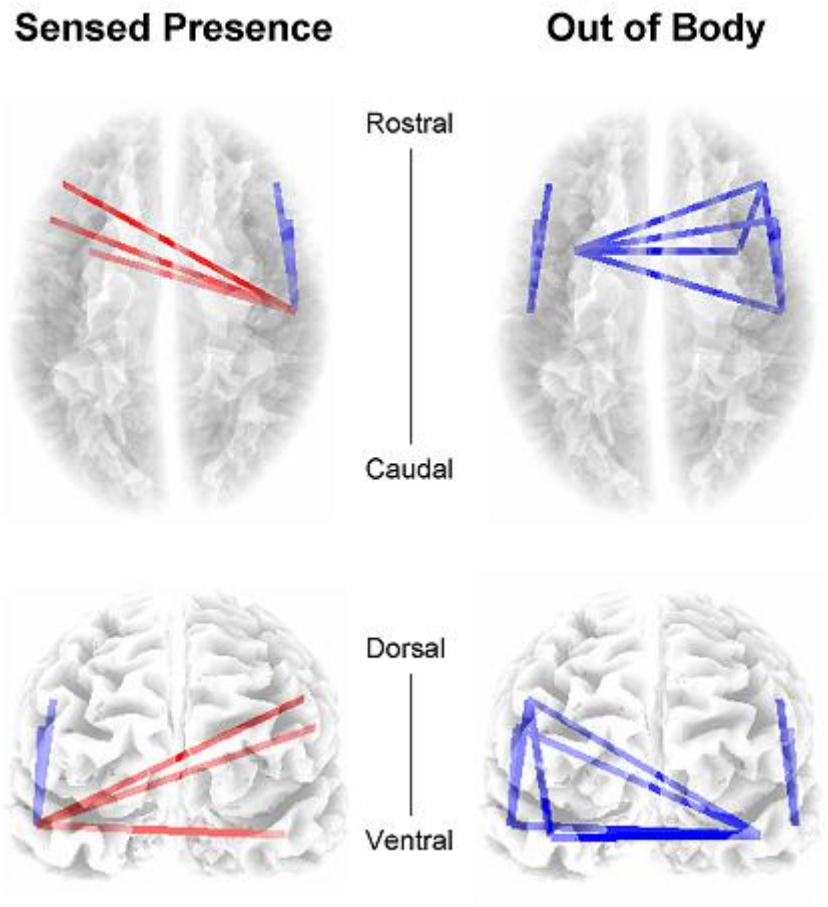

Figure 3. Area or origin and vector for coherence between regions of the cerebrum in the rostral-caudal and dorsal-ventral axes for subjects reporting the sensed presence and the out of body experience. The sensed presence is associated with enhanced coherence in the delta range from the right anterior temporal sources moving into the left anterior hemisphere. The out-of-body experience is associated with coherence within the beta band between left anterior temporal regions and large areas of the right prefrontal volume.

We have also learned that the prototypical "sensed presence" may be an "avatar" for the information obtained through right hemispheric processing. The specific characteristics of the presence, including the visual manifestation, depend upon the degree to which areas are integrated into the experience evoked by the experimental magnetic fields. The patterns we have found most effective appear to be present within the natural world and may be frequently generated by geomagnetic activity or modern electronic technology.

The most obvious and not unexpected discovery has been that there is a large set of conditions that produce these experiences. The appropriately applied transcerebral magnetic fields are only one type of

stimulus which we have assumed is the quintessential form to which all other conditions are transformed or reduced. Secondly, the conditions of the cerebrum, due to intrinsic organization, an early brain trauma, or intrinsic neuroelectrical lability, strongly influence not only the type of experience but the direction of the cerebral organization when the field is applied. Not surprisingly, considering the rapid alteration of global microstates every 80 to 120 ms, some people report sequential sequences of out-of-body experiences and sensed presences.

During specific states the applied field may be sufficient to be discernable as entrainment. Persinger et al (2009) showed that Stage 2 spindles were entrained by application of burst-firing magnetic fields that were presented once every approximately 4 sec. This same burst-firing pattern has been associated with analgesia in both rodents and humans. In rodents 30 min exposure to this type of magnetic field produces an analgesia equivalent to about 4 mg/kg of morphine.

6.0 Conclusions

The maturation of scientific methodology, the systematic application of the most powerful tool of science (the experiment), and the development of technology has revealed the neurophysical correlates of experiences that were historically attributed to cosmic intelligences or non-measureable processes. The direct elicitation of sensed presences and out of body experiences by the prescient and sagacious neurosurgeons of the middle 20th century was to the "parasitic consciousness" of Hughling Jackson's 19th century perspicacious perceptions as was the connection between the "electric charges" within a von Leyden jar or from a Wimshurst Machine and the natural wonder of atmospheric lighting. These cerebral pioneers showed that the complexity and the varieties of consciousness and mystical states could be controlled by the manual activation of the same current source that operated electronic instruments.

However the subtlety and complexity of the electromagnetic energies within the brain that create or are certainly strongly correlated with altered states of consciousness do not require massive currents to be activated. The application of physiologically-patterned, appropriately timed, weak transcerebral magnetic fields within particular contexts can also elicit these states with comparable clarity, personal salience, and emotional potency. The intensity is within the range encountered around electronic equipment within the modern world. Perhaps a metaphor would best reveal the profound implication. A door can be opened with at least two methods. You can kick it open or use a key. The latter requires much less energy but requires the specific access to the appropriate temporal-spatial structure.

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